For each question **Q1 - Q**4 below answer what is printed by the commented line on your answer sheet. If a runtime or compile time error, answer “Err”. If the statement is legal and nothing is printed, answer “Ok”.

```
class A {
private:
   virtual void p( );
protected:
   virtual void q( );
public:
   virtual void r( );
};

void A::p( ) {cout << "A::p" << endl;};
void A::q( ) {cout << "A::q" << endl;};
void A::r( ) {cout << "A::r" << endl;};

class B : protected A {

public:
   void foo( );
};

void B::foo( ) {
   q( );
   r( );
}

int main( ) {
   A a;
   B b;

   a.q( ); // Q1
   a.r( ); // Q2

   b.q( ); // Q3
   b.r( ); // Q4


}
```

For each question **Q5 - Q11** below answer what is printed by the commented line on your answer sheet. If a runtime or compile time error, answer "Err". If the statement is legal and nothing is printed, answer "Ok". For **Q8** and **Q11**, say what is printed by both lines, or "Err" if either line is illegal or produces an error.

```
class Base {
public:
  Base( );
  virtual ~Base( );
};

Base::Base( ) { }
Base::~Base( ) { }

class A : public Base {
public:
  virtual void p( );
  virtual void q( );
};

void A::p( ) {cout << "A::p" << endl;}
void A::q( ) {cout << "A::q" << endl;}

class B : public Base {
public:
  virtual void q( );
  virtual void r( );
};

void B::q( ) {cout << "B:q" << endl;}
void B::r( ) {cout << "B:r" << endl;}
```

```
int main( ) {
   Base* baseP = new A( ); // Q5
   A* aP = new A( );
   B* bP = new B( );

   baseP = aP; // Q6
   aP = static_cast<A*>(bP); // Q7
   aP = dynamic_cast<A*>(bP);
   aP->q( ); // Q8

   aP = baseP; // Q9
   aP = static_cast<A*>(baseP); // Q10
   aP = dynamic_cast<A*>(baseP); // Q11
   aP->p( ); // Q11:w
}
```

For each question **Q12 - Q16** below answer what is printed by the commented line on your answer sheet. If a runtime or compile time error, answer “Err”. If the statement is legal and nothing is printed, answer “Ok”.

```
class A {
public:
  A( );
  A(int);
  virtual ~A( );
  virtual void f(A*);
  int i;
};

A::A( ) : i(-1) {cout << "A0" << endl; i = -2;}
A::A(int k) {cout << "A1" << endl; i = k;}
A::~A( ) {cout << "A-" << endl;}

void A::f(A* p) {cout << (p == this) << endl;}

class B : public  A {
public:
  B( );
  B(int, int);
  virtual ~B( );
  int k;
  int j;
};

B::B( ) : j(0), k(0) {cout << "B0" << endl;}
B::B(int m, int n) : j(5), k(j), A(1) {cout << "B1" << endl;}
B::~B( ) {cout << "B-" << endl;}

int main( ) {
  b0;
  b1(2, 3); // Q12

  std::cout << b0.i << " " << b0.j << " " << b0.k << std::endl; // Q13
  std::cout << b1.i << " " << b1.j << " " << b1.k << std::endl; // Q14

  B* p = &b0;
  p->f(p); // Q15
} // Q16, what if anything is printed when main is exited?
```

For each question **Q17 - Q28** below answer what is printed by the commented line on your answer sheet. If a runtime or compile time error, answer "Err". If the statement is legal and nothing is printed, answer "Ok".

```
class A {
public:
  A( );
  int i;
};

A::A( ) : i(-1) { }
```

```
// main.cpp
void f1(A ap) {
   ap.i = 0;
}

void f2(A& ap) {
   ap.i = 1;
}

void f3(A* ap) {
   ap->i = 2;
}

int main( ) {
   A a;
   A* aP = &a;
   A& aR = a;

   f1(a);
   std::cout << a.i << std::endl; // Q17
   f1(aP);
   std::cout << a.i << std::endl; // Q18
   f1(aR);
   std::cout << a.i << std::endl; // Q19

   f2(a); // Q20
   std::cout << a.i << std::endl; // Q21
   f2(aP); // Q22
   std::cout << a.i << std::endl; // Q23
   f2(aR); // Q24
   std::cout << a.i << std::endl; // Q25

   f3(a);
   std::cout << a.i << std::endl; // Q26
   f3(aP);
   std::cout << a.i << std::endl; // Q27
   f3(aR);
   std::cout << a.i << std::endl; // Q28
}
```

For each question **Q29 - Q50** below answer what is printed by the commented line on your answer sheet. If a runtime or compile time error, answer “Err”. If the statement is legal and nothing is printed, answer “Ok”.

```
class A {
private:
  virtual void p( );

public:
  A( );
  virtual void q( );
  virtual void r( );
  void s( );
  void t( );
  int i;
  int j;
private:
  virtual void u( );
};

A::A( ) {i = 1; j = 2;};

void A::p( ) {cout << "A::p" << endl;}
void A::q( ) {cout << "A::q" << endl;}
void A::r( ) {cout << "A::r" << endl;}
void A::s( ) {cout << "A::s" << endl; u( );}
void A::t( ) {cout << "A::t" << endl;}
void A::u( ) {cout << "A::u" << endl;}

class B : public A {

public:
  B( );
  void q( );
  void r( );
  virtual void s( );
  void t( );
  int j;
};

B::B( ) : A( ) {j=3;};
void B::q( ) {cout << "B:q" << endl;}
void B::r( ) {cout << "B:r" << endl;}
void B::s( ) {cout << "B:s" << endl;}
void B::t( ) {cout << "B:t" << endl;}

class C : public B {
public:
  C( );
  virtual void s( );
  void t( );
  int j;
};

C::C( ) : B( ) {j=4;}
void C::s( ) {cout << "C::s" << endl;}
void C::t( ) {cout << "C::t" << endl;}

int main( ) {
  A a;
  B b;
  C c;

  A& aR = b;
  B& bR = c;
  A* aP = &b;
  B* bP = &c;

  aR.q( ); // Q29
  aR.s( ); // Q30
  aR.t( ); // Q31
  bR.r( ); // Q32
  bR.s( ); // Q33
  bR.t( ); // Q34

  aP->q( ); // Q35
  aP->r( ); // Q36
  aP->s( ); // Q37
  aP->t( ); // Q38
  bP->q( ); // Q39
  bP->r( ); // Q40
  bP->s( ); // Q41
  bP->t( ); // Q42

  a = c;
  a.q( ); // Q43
  a.r( ); // Q44
  a.s( ); // Q45
  a.t( ); // Q46
  std::cout << aP->i << std::endl; // Q47
  std::cout << aP->j << std::endl; // Q48
  std::cout << bP->i << std::endl; // Q49
  std::cout << bP->j << std::endl; // Q50
}
```